formation and destruction of unstable intermediate compounds, the author asserting that this theory, in spite of certain imperfections, has been the guiding beacon in all his researches on catalysis.

G. T. M.

MATHEMATICS: PURE AND APPLIED.

(1) *Vectorial Mechanics*. By Dr. L. Silberstein. Pp. viii + 197. (London: Macmillan and Co., Ltd., 1913.) Price 7*s*. 6*d*. net.

(2) *An Introduction to the Mathematical Theory of Attraction*. By Dr. F. A. Tarleton. Vol. ii. Pp. xi + 207. (London: Longmans, Green and Co., 1913.) Price 6*s*.

(3) *A First Course in Projective Geometry*. By E. Howard Smart. Pp. xxiii + 273. (London: Macmillan and Co., Ltd., 1913.) Price 7*s*. 6*d*

(1) DR. SILBERSTEIN'S "Vectorial Mechanics" is an able exposition of the power of vector analysis in attacking certain types of physical problems. Heaviside's modification of Hamilton's original vector and scalar notations is adopted throughout. So far as the simpler applications of vector analysis go, the question of notation is apparently of little consequence. Almost every vector analyst who writes a book on the subject has his own pet notation; and there is a tendency for these authors to fail to recognise that their best creations are usually Hamilton's originals disguised. Even Dr. Silberstein, who knows and works quaternions, ascribes to Heaviside a formula given long ago by Hamilton, assigns to Clifford (1878) a problem which is completely solved in the first edition (1867) of Tait's "Quaternions," and refers to Henrici and Turner as authorities in connection with a simple geometrical problem given in Kelland and Tait's "Introduction to Quaternions." One might with as much historic truth ascribe the proposition Euclid i. 47 to the first English examiner who set it in an examination paper. Indeed, the historic references throughout the book are not all that might be desired. For example, it is incorrect to speak of Willard Gibbs as the one to whom, after Hamilton, the discovery of the fundamental properties of the linear vector function is due. What of Tait's powerful paper of 1868 on the rotation of a rigid body about a fixed point? It positively bristles with new-found properties and applications of the linear vector function. Dr. Silberstein's own chapter v. is simply a reproduction of part of this memoir. Then in the second edition (1873) of his treatise on "Quaternions," Tait for the first time develops the application of the linear vector function to strains; and in the last chapter of Kelland and Tait's "Introduction to Quaternions" (1873) presents the theory in a different form. Willard Gibbs's "Vector Analysis" (not published) was printed for the use of his students in 1881 and 1884. Apart from new names and a new and extremely interesting presentation, it is doubtful if Gibbs gave in that pamphlet any important property of the linear vector function which was not to be found in the pages of either Hamilton or Tait.

Then as regards the differential operator ∇ it was unquestionably Tait who, first in his paper on Green's and allied theorems (1870), and afterwards in his treatise on quaternions (second and third editions), developed it and showed forth its power. Willard Gibbs got it partly from Tait's "Quaternions" and partly from Maxwell's "Electricity and Magnetism"; and Maxwell got it directly from Tait. Yet while giving great credit to Gibbs and Heaviside, Dr. Silberstein does not mention Tait's name once. The manner in which Dr. Silberstein leads up to Stokes's "Theorem" is not convincing, that is, if the explanation is meant to be a proof. Phrases like "we may conclude" and "we may consider" are scarcely satisfactory in establishing a far-reaching mathematical transformation. Moreover, no attempt is made to establish the useful vector extensions of the theorems of Gauss and Stokes. It is, indeed, in these integral theorems involving the ∇ that, as compared with the quaternion vector analysis, the artificiality of other vector analyses mainly appears. The transformations lack flexibility. The reason for this is that outside the quaternion vector analysis the reciprocal of a vector is tabu, and the associative law in products is despised.

Apart from the necessary imperfections of a non-associative vector algebra, Dr. Silberstein's book contains many good things. In his treatment of the rotation of a solid body and of strain there is not so much of novelty, except when in the latter case he considers discontinuous motions. In the chapter on hydrodynamics, however, there are certain interesting developments which demonstrate the directness and value of vector methods. On p. 143 the long-winded semi-Cartesian transformation is needlessly laborious; for at once in quaternion notation:

$$S\sigma\nabla . \sigma = V\sigma V\nabla\sigma + \nabla_1 S\sigma_1\sigma = V\sigma V\nabla\sigma + \tfrac{1}{2}\nabla\sigma^2,$$

where σ is the fluid velocity.

(2) After a lapse of fourteen years Prof. Tarleton has brought out the second volume of his "Introduction to the Mathematical Theory of Attraction," the first volume of which was reviewed in NATURE for April 29, 1899. The chapters are numbered consecutively with the chapters of the first volume. An elegant discussion of spherical and ellipsoidal harmonics occupies chapter viii. In chapter ix. the author develops on familiar

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lines the more elementary theory of magnetism, permanent and induced, with a brief sketch of the general theory of terrestrial magnetism. Chapters x., xi., xii. take up respectively electric currents, dielectrics, and the electromagnetic theory of light. The exposition is clear throughout, and well adapted to a student reading the subject for the first time. At the same time it will probably be felt by many that the book would have appealed to a wider audience if the spherical harmonic methods mathematically developed had been applied to definite problems in electrical or magnetic distributions. The author, however, is quite consistent in this neglect of practical applications; for although chapter xii. ends with the statement that the ratio of the electromagnetic to the electrostatic unit of electric charge is approximately 3×10^{10}, it is nowhere stated that this is the numerical value of the velocity of light.

(3) Mr. E. H. Smart's "First Course in Projective Geometry" is both well planned and well written. With the exception of a brief introduction to the method of projection in space, the first six chapters are devoted to the plane geometry of triangles, quadrilaterals, and circles, in which the principles of correspondence and duality, harmonic ranges, inversion, similitude, poles and polars, are developed in a systematic manner. In chapter vii. further theorems and problems on projection are given, and these suffice for what the author regards as the main purpose of his book, namely, a logical, coherent discussion of the geometry of the conic sections. In the later chapters the principle of duality is freely introduced, and the book finishes with typical examples of reciprocation. Most of the chapters contain brief historic notes which cannot fail to interest the student.

OUR BOOKSHELF.

Materials and Methods in High School Agriculture. By Prof. W. G. Hummel and Bertha R. Hummel. Pp. xi+385+plates. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1913.) Price 5*s*. 6*d*. net.

IN discussing the scope of their work the authors begin with a definition of the object of agricultural work in elementary schools and also in the universities. They then find that the position of agriculture in high schools lies intermediately between these two positions. The purposes of agricultural work in the elementary schools are stated to be the opening of the minds of children to the common phenomena of nature, the inculcation of habits of observation, and the setting up of higher ideals in country life, but not to make farmers or farm labourers. In the colleges, on the other hand, the work lies in the investigation of the more fundamental problems of agricultural science and practice. The high schools should teach practical agriculture, educating their students for the actual business of the farmer; the course should not, however, be narrowly vocational, but should be cultural and disciplinary as well, and should prepare the students to be broad-minded and intelligent, progressive citizens.

Considerable stress is laid upon the necessity for finding suitable teachers; the teacher must not only possess agricultural knowledge, but be able to impart it to others. Neither the purely scientific man nor the purely practical man has turned out a success. The former fails because he lacks the proper point of view, and knows nothing of practical farming conditions; the latter fails because he does not know the first principles of the subject, and is unacquainted with the scientific basis of agriculture.

The book is full of interest, and can be cordially recommended to all who are engaged in the work of agricultural education at schools, farm institutes, and colleges.

The Deciding Voice of the Monuments in Biblical Criticism. By Dr. M. G. Kyle. Pp. xvii+320. (London: S.P.C.K., 1912.) Price 4*s*. net.

THE author of this work would probably not resent the suggestion that he writes as an advocate or partisan, rather than as an impartial assessor, in a long-drawn-out dispute. The field he surveys is a well-trodden one—the relation between the Bible and the monuments—and his attitude is that of the most traditional and conservative of writers on this subject. His thesis throughout is to the effect that modern archæological study has entirely disposed of the claims advanced on behalf of the textual criticism of the Old Testament. In his view the whole work of the critical school is discredited, and the labours of Hebrew scholars for more than a century past, so far from resulting in a truer and more accurate appreciation of the Hebrew text, have been worse than useless. His position may be indicated by the fact that he maintains the unity of the book of Isaiah, and holds that the book of Daniel embodies the prophecies of a historic person of that name who prophesied in Babylon during the exile, and was written by him or by one of his contemporaries. It does not lie within the scope of this journal to follow the author along his controversial path. But with the best will in the world to be convinced, we cannot help feeling that he is engaged in that rather pathetic process of trying to put back the hands of the clock. We feel sure he would have been far more convincing had he proved himself a less thorough-going partisan.

Astronomy. By Ellison Hawks. Pp. 120. (Manchester: Milner and Co., n.d.) Price 1*s*. net.

IN these 120 pages the author presents the subject of astronomy in such a way that the beginner will wish to carry his reading further. The style is elementary, clear, and chatty, and the reader is led on from one subject to another in a natural

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